Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Feb 2014

Project Reference Number

NIA_NGGT0049

Project Registration

Project Title

Investigation into the use of constrained-layer damping

Project Reference Number

NIA_NGGT0049

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2014

Project Duration

5 years and 1 month

Nominated Project Contact(s)

Paul Connolly,
.box.innovationtransmission@nationalgrid.com

Project Budget

£290,761.00

Summary

High levels of HFAE can cause fatigue failures at welded features such as pipe supports and small bore connections. National Grid has experienced fatigue failures as a result of this phenomenon at a number of compressor sites including Carnforth Units A/B (failure of a blank weldolet) and Moffat Unit B (failure of the recycle line due to a longitudinal crack through a main weld).

The conventional approach for the control of vibrations is to avoid resonance caused by the coincidence of the excitation frequency, and any natural frequency of a system. This is not always practical, particularly if vibrations occur over a wide range of frequencies. Constrained layer damping (CLD) is a passive treatment using a three-layered sandwich system whereby viscoelastic layers (materials having both viscous and elastic properties) are sandwiched between constraining layers of stiff materials such as steel, aluminium, titanium or carbon fibre composite. The increased availability of polymeric materials, which have viscoelastic properties and high damping capabilities has made it possible to control the structural vibrations. The polymers are commonly used in two basically different configurations to dissipate the mechanical energy of vibrations as heat. Generally, the constrained layer damping system is used for very stiff structures, across industries such as aircraft, spacecraft, appliance, and computer industries.

Increased understanding of HFAE leading to efficient and effective attenuation of the resonant frequencies will lead to improved mitigation methods and therefore improved maintenance and inspection routines. Hence National Grid initially commenced investigation into the issue under project - “Develop novel mitigation method for high frequency main pipework vibration” NIA_NGGT0008. Project NGGT0008 is continuing to develop a grouted ring solution however the potential of CLD is such that it could offer improved performance both in parallel with and combined with the grouted ring. There is no duplication between NGGT0008 and this project, both will be complimentary in delivering the most optimal solution for each installation.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Pipework at National Grid compressor facilities is susceptible to acoustic fatigue caused by the flow of gas and associated pressure drop through the valves. As this happens the internal acoustic energy is generated and transmitted to downstream piping and leading to severe piping excitation. At junctions with small bore pipework, dynamic differential movements and high stress concentrations can lead to high frequency acoustic excition (HFAE) failure.

The most effective solutions available at present are extremely costly and involve large-scale redesigns, focusing on either the flow itself or strengthening of the main pipe through increased wall thickness. Currently a failure, or anticipated failure, would have to be resolved by increasing the pipe wall thickness, or by reducing gas flows, both of which would require significant outages and re-design. It is intended to develop constrained-layer damping (CLD) as solution to HFAE that is both simple and low cost.

Method(s)

The project deliverables include:

1. Procurement of test rig and establishing performance
2. Constrained Layer Damping optimisation and testing
3. Constrained Layer Damping adhesion and sealant tests
4. Investigation of Constrained Layer Damping temperature sensitivity
5. Site review
6. Procurement and solution manufacture, including CLD and/or grouted rings
7. Field tests -Baseline testing and setup
8. Field tests -Installation, testing and decommissioning
9. Analysis of Results

2015 update: The project is about to commence the site review stage. It has been identified that more internal resource is required to for the development and assess of the site selection aspects. No other changes are required for the project.

Update: The project requires an additional six months to complete the field trials due to operational and maintenance requirements of the selected live compressor unit making it unavailable as planned for the field trials, in addition the preparatory works to prepare the unit for the trial were more complex and are taking longer to complete than originally anticipated in the scoping of the project.

Other deliverables added are elements of an implementation plan including a vibration management procedure, work procedures for methods of mitigation, an engineering bulletin and delivery of a briefing to engineers in the learning developed by the project. Delivery of these elements further extends the project duration to October 2017.

2018 Update: A number of issues arose during the installation of CLD at Carnforth for which additional time is required to complete the project. Installation of CLD was carried out on at Carnforth prior to installation of conventional acoustic lagging. A recent change in coating procedure means that pipework which is lagged should be treated as if it is buried and a higher coating specification is required to mitigate the risk of Corrosion Under Insulation (CUI). Consequently, the PA10 coating system in place during the pre-installation survey, as was expected to be in place after coating repairs, was changed to a CW5 coating system. The CW5 coating is thick and applied by brush, which leaves a very rough and undulating surface, and is therefore significantly different from the PA10 coating.

Due to the surface finish of the CW5 coating, difficulties were experienced initially in achieving an acceptable bond for the damping material. To ensure that the vibration damping material can be installed on the different pipe coating surfaces on the NTS, additional time was required to develop a suitable solution.

Based on this additional knowledge regarding the different pipework coatings which might be encountered on National Grid’s assets, the CLD work procedure under development within the current project will need to be revised to reflect this additional knowledge regarding pipe coatings, and enhancements to the recommended installation process. As a result, additional time is required to complete and sanction the work procedure, and deliver the necessary training to the pipeline technicians.

Scope

High levels of HFAE can cause fatigue failures at welded features such as pipe supports and small bore connections. National Grid has experienced fatigue failures as a result of this phenomenon at a number of compressor sites including Carnforth Units A/B (failure of a blank weldolet) and Moffat Unit B (failure of the recycle line due to a longitudinal crack through a main weld).

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Objective(s)

To investigate the performance and the limitations of constrained layer damping technique as a low cost solution for high frequency acoustic excitation on National Grid Compressor site pipework.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The development of the constrained layer damping technique as a low cost solution for high frequency acoustic excitation.

Project Partners and External Funding

Supplier – DNV GL

External funding - Nil

Potential for New Learning

The project looks to develop learning on a new technique suitable for the mitigation of acoustic fatigue failure of pipework on National Grid compressor sites. New learning includes the identification of performance defining features for reducing dynamic stresses, determination of the limitations of the CLD solution, and trials to ensure the solution is practical and durable, i.e. performance will not decay over a temperature range and that it will not detrimentally affect the pipe wall or coating.

Scale of Project

The first phase of the project is at the laboratory scale as the investigation is looking to determine the potential of this new technology as a solution to HFAE through experimental trials. The second phase will involve field trials in the operational environment to ensure any solution is suitable for implementation across the network.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The laboratory tests will take place at the DNV GL facility. For the field trials there are various National Grid sites that have had issues related to HFAE in the past and may be suitable for a trial. A site will be chosen to host the field trials based on factors such as the presence of HFAE on the site, pipe work suitable for installation of the solutions, site availability and ease of site operation for trials. If the project is successful, the technology would be implemented at National Grid compressor sites across the UK.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£178,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

Savings are estimated in the region of £90,000 per installation. Total number of pipe work connections at risk – 60. Total savings in region of £90,000 x 60 = £5.4m.

Please provide a calculation of the expected benefits the Solution

The benefits of developing the CLD technology to reduce the threat of fatigue failure due to HFAE for compressor and AGI pipework are significant for both safety and financial related benefits.

The failure of main pipe welds, pipe supports and impulse pipework can be classed as RIDDOR reportable, a serious safety risk as well as potentially leading to large releases of natural gas into the environment.

A number of National Grid compressor sites have experienced problems with HFAE including Carnforth, Abedeen and Bishop Auckland. It is estimated that a total of 60 small bore connections are at risk. The failure of compressor discharge process/impulse pipework, caused by high dynamic stresses, is likely to cost in the region of £100,000 (including materials, manpower and nitrogen purging plus the risk of a loss of network flexibility with compressor units on outage).

A retrofit of a CLD solution is intended to be a low cost simple solution with minimal disruption to site operations costing up to £10,000.

Total savings in region of £90,000 x 60 = £5.4m

Please provide an estimate of how replicable the Method is across GB

The solution will be rolled out across the 24 National Grid compressor station sites where acoustic fatigue failure is a problem, or believed to be a potential problem.

Please provide an outline of the costs of rolling out the Method across GB.

It is estimated the cost of implementation per installation would be between £5,000 and £10,000.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☑ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

If successful the solution may be suitable for HFAE mitigation at pipework junctions on gas transmission and distribution above ground installations.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project is aligned to the reliability theme.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

An initial market study was carried out to establish existing and potential solutions for pipe work fatigue caused by HFAE. The most effective available solutions are extremely costly and involve large-scale redesigns hence the development of CLD will offer a unique solution that is low cost and simple to install. The project will be run in conjunction with NGGT_NIA0008 (to develop a grouted ring solution) to ensure the mitigation methods are optimal for each installation on the NTS.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

n/a

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

n/a

This project has been approved by a senior member of staff

☑ Yes